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(54) Service prioritization in a cellular telephone system

(57) A system for servicing call establishment requests in a cellular telephone system on a priority basis is described. In this system, a base station receives a call establishment request either via an external MTSO (mobile telephone switch office) or PSTN (public telephone switch network), or internally from a call establishment request, broadcasted by a mobile unit associated with a first subscriber within the cell of interest. Both the base station and the mobile unit are located in a cell (i.e., the cell of interest) of the cellular telephone system. The base station determines whether it has a free channel to service the call establishment request. If the base station does not have a free channel to service the call establishment request, then a call processor determines a service priority level of the first subscriber. This service priority level is communicated to the base station. The base station processes the call establishment request in accordance with the service priority level of the first subscriber and service priority levels of second subscribers that are involved in telephone calls active in the cell.

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priority calling service to make or receive calls despite excess demand in the cellular network. If lower priority customer calls (Basic or Economy) occupy the facilities, these lower priority calls are automatically dropped to serve the Priority customers.

(2) Premium Service - For the second most expensive service rate, these customers receive service where their calls are not dropped to serve Priority Service Customers. Also, if lower priority customer calls (Economy) occupy the facilities, these lower priority calls are dropped automatically to serve the Premium customers.

(3) Normal Service - For the regular service rate (third most expensive rate), these customers receive service with a normal priority. Priority and Premium Service customers do not displace the established calls of Normal Service customers. However, Normal Service customers receive a lower priority in establishing a call. That is, this level of service does not displace lower priority calls (Basic or Economy).

(4) Basic Service - For a reduced service rate (the fourth highest rate), these customers receive service with a low priority which allows their calls to be dropped to serve Priority Customers.

(5) Economy Service - For an even lower service rate (the most inexpensive rate), these customers receive service with a low priority which allows their calls to be dropped to serve both Priority and Premium Customers.

FIG. 1 is a block diagram of a telephone communication system 102 according to a preferred embodiment of the present invention. The telephone communication system 102 includes a public telephone switch network (PTSN) and a plurality of cellular telephone cells 104, 118, 130. At any time, zero or more mobile cellular telephones (also called "mobiles" or "mobile units") may be located in the cells 104, 118, 130, such as mobile 106 which is located in cell 104.

Each cell 104, 118, 130 includes a base station, such as base station 108 in cell 104. Each base station, such as base station 108, includes a database 110. This database 110 includes a list (or table) having an entry for each of the telephone calls which are currently active in the cell 104. The entries store information that identifies the service levels (also called level-of-services) respectively associated with the mobiles in the cell 104 that are involved in the active telephone calls.

The cells 104, 118, 130 are connected to the PTSN 128 via mobile telephone switch offices (MTSO) 112, 138. One or more cells 104, 118, 130 may be associated with each of the MTSOs 112, 138. According to the present invention, each MTSO 112, 138 includes a call processor and a database, such as call processor 114 and database 116 in MTSO 112. Preferably, the call processor 114 is a processor operating in accordance with control logic, such as computer software. Alternatively,

the call processor 114 is a primarily hardware state machine.

The database 116 includes a list or table that includes an entry for each mobile 106, 120, 122 contained in the cells 104, 118 with which it is associated. The entries store information that identifies the service levels (also called service priority levels and level-of-services) for these mobiles 106, 120, 122.

The general structure and operation of the mobiles 106, 120, 122, 132, the base stations 108, 124, 134, the MTSOs 112, 138, and the PTSN 128 are well known. Accordingly, the description presented herein focuses on the features of these units which support the prioritization of telephone call requests according to the present invention.

FIG. 2 is a flowchart 202 depicting the manner in which a mobile establishes a telephone call to a public network subscriber according to a preferred embodiment of the present invention. For illustrative purposes, flowchart 202 is described with respect to mobile 106 located in cell 104. Flowchart 202 begins with step 204, where control immediately passes to step 206.

In step 206, the mobile 106 broadcasts a call establishment request to establish a call with a particular public network subscriber.

In step 208, the base station 108 located in cell 104 receives this call establishment request. As will be appreciated, each base station 108 has a finite number of channels over which telephone calls may be established. Generally, one telephone call may be established for each channel. In step 208, the base station 108 analyzes its resources to determine whether it has a free channel to service the call establishment request.

As indicated by decision step 210, if the base station 108 has a free channel to service the call establishment request, then step 220 is performed. In step 220, a call is established between the mobile 106 and the public network subscriber in a well known manner. Operation of the flowchart 202 is complete after step 220 is performed, as indicated by step 218.

If the base station 108 does not have a free channel to service the call establishment request, then step 212 is performed. In step 212, the base station 108 notifies its MTSO 112 that it does not have sufficient capacity to service the call establishment request.

In step 214, the call processor 114 in the MTSO 112 accesses the database 116 to determine the service priority level of the mobile 106. The call processor 114 transmits this information to the base station 108.

In step 216, the base station 108 processes the call establishment request in accordance with the mobile 106's service priority level, and the service priority levels associated with all active calls in the cell 104. For example, if the service priority level of the mobile 106 is "Priority Service", then the base station 108 accesses its database 110 to determine whether there are any active calls associated with Basic or Economy subscribers. If there is an active call associated with a Basic or an Economy subscriber, then the base station 108 drops that

mobile 106 and the subscribers associated with the active calls in the cell 104 are such that the call involving the mobile 106 cannot be serviced, then a message is sent back to the mobile 106 notifying the mobile 106 that service capacity has been reached, and that the call establishment request could not be serviced.

Processing to establish a call between mobiles 106 and 120 continues if a call was established between the mobile 106 and the destination MTSO 112 in either steps 430 or 416. This is indicated by decision step 418. If a call was established between the mobile 106 and the destination MTSO 112 in either steps 430 or 416, then step 420 is performed. If a call was not established, then operation of flowchart 402 is complete, as indicated by step 434 (path 436).

In step 420, the destination MTSO 112 identifies in a well known manner the cell (in this case, cell 118) in which the destination mobile 120 is contained. The MTSO 112 identifies the base station 124 in cell 118 of the call. The base station 124 analyzes its resources to determine whether it has a free channel to service the call.

As indicated by decision step 422, if the base station 124 has a free channel to service the call, then step 432 is performed. In step 432, the call is serviced using a free channel in a well known manner. Operation of the flowchart 402 is complete after step 432 is performed, as indicated by step 434.

If the base station 124 does not have a free channel to service the call, then step 426 is performed. In step 426, the base station 124 notifies its MTSO 112 that it does not have sufficient capacity to service the call. The call processor 114 in the MTSO 112 accesses the database 116 to determine the service priority level of the destination mobile 120. The call processor 114 transmits this information to the base station 124.

In step 428, the base station 124 conditionally processes the call in accordance with the mobile 120's service priority level, and the service priority levels associated with all active calls in the cell 118. The operation of step 428 is similar to step 216 in FIG. 2, described above (except in this case, the analysis is conducted with respect to the mobile 120's service priority level, and the service priority levels associated with all active calls in the cell 118). If the service priority levels of the mobile 120 and the subscribers associated with the active calls in the cell 118 are such that the call involving the mobile 120 cannot be serviced, then a message reporting this is sent back to the MTSO 112 and the mobile 106 in the cell 104. If, instead, the call is established, then a message to this effect is sent to the MTSO 112 so that the MTSO 112 can update its billing records. Operation of the flowchart 402 is complete after step 428 is performed, as indicated by step 434.

Thus, as is clear from the above, whether or not a call between two mobile units will be established depends on the priority service levels associated with each mobile, and the priority service levels associated with subscribers involved in telephone calls active in the

cells in which the two mobiles are contained. Generally, the overall priority of the two mobiles is limited by the lowest priority of the two. For example, if one mobile has a priority of Premium, and the other has a priority of Economy, then with all else being equal, whether or not the call will be established will be governed by the Economy level (of course, the priority service levels associated with subscribers involved in telephone calls active in the cells in which the two mobiles are contained must be considered).

In order to allow customers the ability to vary their access capability and the cost of their calls, as users they can enter special control sequences (for example, by using the asterisk and the pound keys) to upgrade or downgrade their priority level for a special "per-use" fee that applies to that one telephone call. This higher "per-use" fee allows Basic or Economy customers the ability to make special priority calls if they are blocked or dropped and are willing to pay more to gain access to the network during peak demand times.

Other Service Priority Levels

As discussed above, the present invention preferably supports five service priority levels: Priority Service, Premium Service, Normal Service, Basic Service, and Economy Service. However, the present invention is intended and adapted to support other priority levels (either in addition to or instead above the five priority levels just listed). In one embodiment, the present invention supports a sixth priority level in addition to the above. This sixth priority level is called "Emergency Service," and it is the highest priority level (i.e., higher than Priority Service). The Emergency Service priority level is designated for federal, state, and/or local emergency services personnel or critical government functions. These designated customers receive the highest priority service to make or receive calls despite excess demand in the cellular network. If lower priority customer calls (Basic or Economy) occupy the facilities, these lower priority calls are automatically dropped to serve the Emergency Service customers. Also, during times designated by the cellular service provider as an "emergency condition," such as a weather or natural catastrophe, or a civil emergency, these Emergency Customers preempt calls of any of the lower priority customers (Priority, Premium, Normal, Basic, or Economy).

Prioritized Hand-Off

According to one embodiment, the present invention supports prioritized hand-off. "Hand-off" is a well known term that refers to the process that occurs when a mobile with an active call moves from one cell to another cell in the cellular network. According to the present invention, as an active call is passed from a first cell (called "the old cell") to a second cell (called "the new cell"), the scarce resources of the new cell are monitored to determine if there is enough capacity to support the call. If so,

- (1) receiving a call from a PTSN (public telephone switch network) subscriber to a mobile unit located in a cell of the cellular telephone system;
- (2) determining whether a base station contained in said cell has a free channel to service said call;
- (3) if said base station does not have a free channel to service said call, then determining a service priority level of a subscriber associated with said mobile unit; and
- (4) processing said call in accordance with said service priority level and with service priority levels of additional mobile subscribers involved in telephone calls active in said cell.
5. The method of claim 4, wherein step (4) comprises the steps of:
- if said base station does not have a free channel to service said call, then determining whether any of said additional mobile subscribers involved in telephone calls active in said cell has a service priority level sufficiently less than said service priority level of said subscriber;
- if at least one of said additional mobile subscribers involved in telephone calls active in said cell has a service priority level sufficiently less than said service priority level of said subscriber, then terminating a telephone call involving said at least one of said additional mobile subscribers; and
- servicing said call using a channel formerly being used to service said terminated telephone call.
6. A method of servicing call establishment requests in a cellular telephone system, comprising the steps of:
- (1) receiving at a first base station a call establishment request to establish a telephone call between a first mobile unit located in a first cell and a second mobile unit located in a second cell, said first base station also located in said first cell;
- (2) determining whether said first base station has a free channel to service said call establishment request;
- (3) if said first base station does not have a free channel to service said call establishment request, then determining a first service priority level of said first subscriber;
- (4) determining whether any third subscribers involved in telephone calls active in said first cell has a service priority level sufficiently less than said first service priority level of said first subscriber;
- (5) if at least one of said third subscribers in said first cell has a service priority level sufficiently less than said first service priority level of said first subscriber, then terminating a telephone call involving said at least one of said third subscribers; and
- (6) servicing said call establishment request in said first cell by using a channel formerly being used to service said terminated telephone call to establish a call between said first mobile unit and a mobile telephone switch office (MTSO) associated with said second cell.
7. The method of claim 6, further comprising the steps of:
- (7) determining whether said second base station has a free channel to service said call establishment request to said second mobile unit in said second cell;
- (8) if said second base station does not have a free channel to service said call establishment request, then determining a second service priority level of said second subscriber;
- (9) determining whether any fourth subscribers involved in telephone calls active in said second cell has a service priority level sufficiently less than said second service priority level of said second subscriber;
- (10) if at least one of said fourth subscribers has a service priority level sufficiently less than said second service priority level of said second subscriber, then terminating a second telephone call involving said at least one of said fourth subscribers; and
- (11) servicing said call establishment request by using a channel formerly being used to service said terminated second telephone call to establish a call between said MTSO and said second mobile.
8. The method of claim 6, wherein said first subscriber may modify said first service priority level on a per call basis.
9. A cellular telephone system, comprising:
- means for receiving a call establishment request broadcasted by a mobile unit associated with a first subscriber, said mobile unit located in a cell of said cellular telephone system;
- means for determining whether a free channel to service said call establishment request exists;
- means for determining a service priority level of said first subscriber if a free channel to service said call establishment request does not exist; and
- processing means for processing said call establishment request in accordance with said service priority level of said first subscriber and service priority levels of second subscribers involved in telephone calls active in said cell.
10. The cellular telephone system of claim 9, wherein said processing means comprises:

FIG. 1

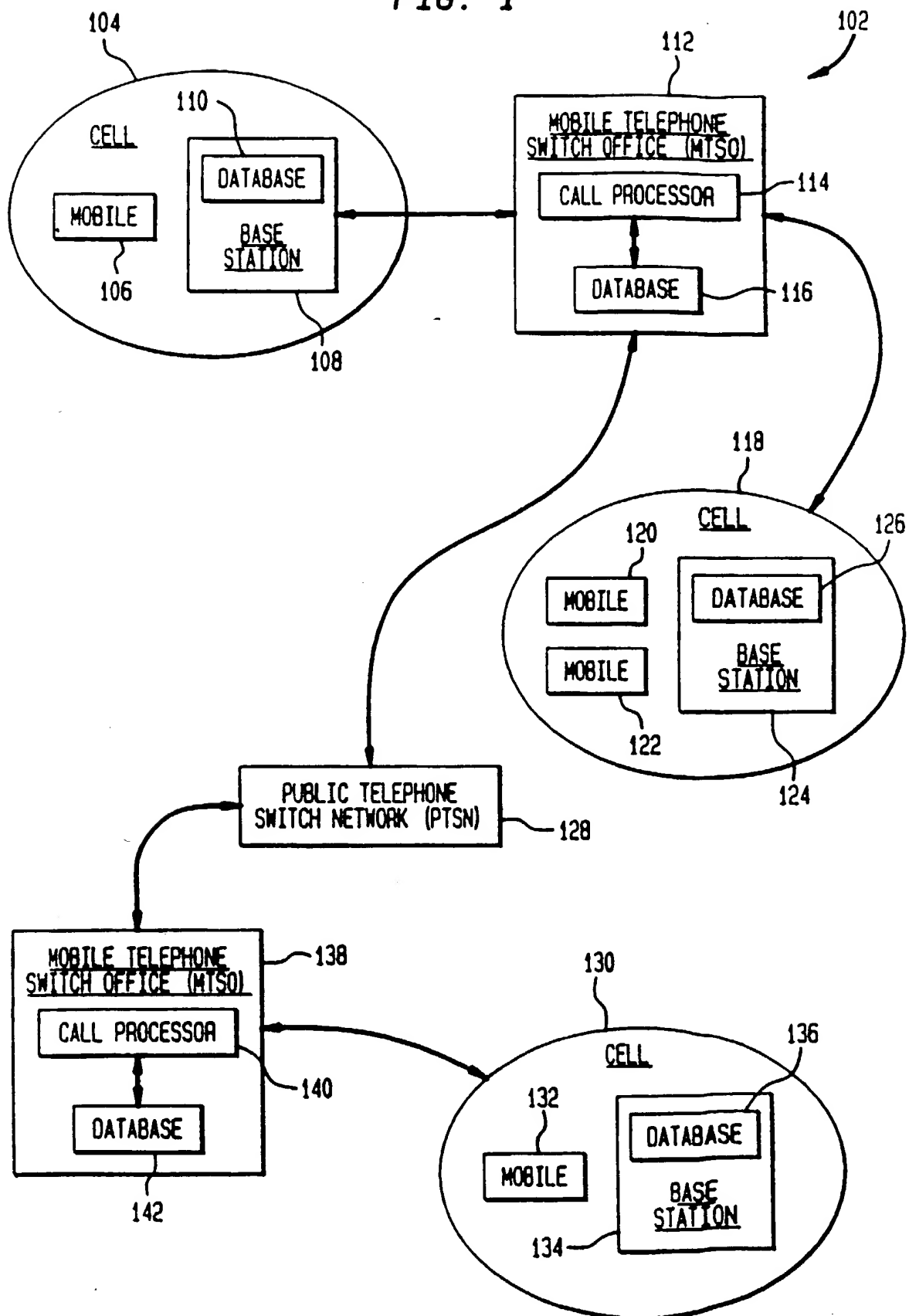


FIG. 3

